

EXAM #2

MECHANICS

15% of the final grade

Winter 2016

Name: _____

Each multiple-choice question is worth 3 marks.

1. When an object is free-falling towards the ground, the instantaneous power of the force of gravity acting on the object is...

- getting larger.
- constant
- getting smaller.

2. The potential energy of an object at the position (x,y) is given by the formula $U = 3N \cdot x - 4N \cdot y$. What is the magnitude of the force exerted on the object when it is at the position $(5, 2)$?

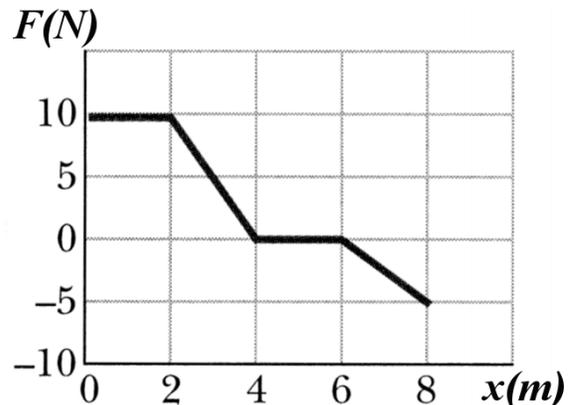
Answer : _____

3. A book of mass m is on the floor of a bus. The coefficient of static friction between the floor of the bus and the book is μ . What is the maximum speed that the bus can have so that the book does not slide towards the back?

- μg
- μ/g
- μmg
- There is no maximum speed.

4. Here is the graph of the force exerted on an object as a function of the position. What is the work done on this object between $x = 0$ and $x = 8$ m?

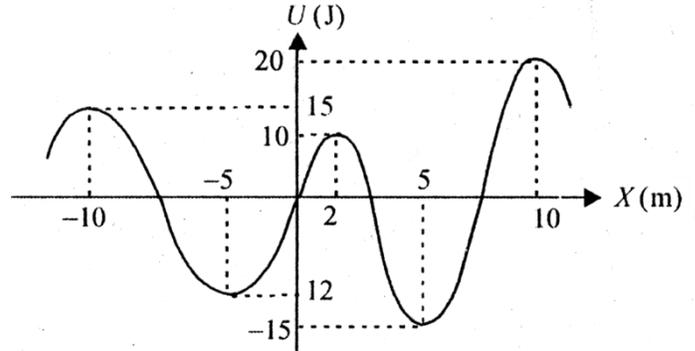
Answer : _____



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5. The graph shows the potential energy of a 2 kg object as a function of its position x . Which of the following statements is(are) correct? (You must have all the correct statements to obtain the 3 marks for this question.)

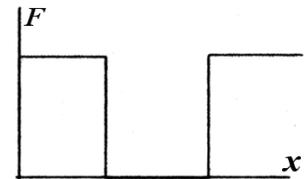
- If the object is at $x = 0$ m, then the force acting on the object is directed towards the positive x -axis.
- The object can be in stable equilibrium at $x = 2$ m.
- The object has a maximum speed of 15 m/s when it is at $x = 5$ m.
- If the object has a speed of 3 m/s towards the positive x -axis when it is at $x = -10$ m, then it can go to $x = 10$ m.
- None of these statements is true.



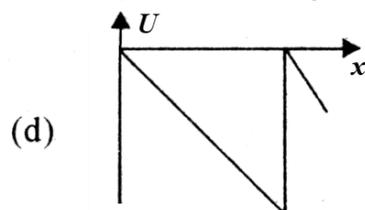
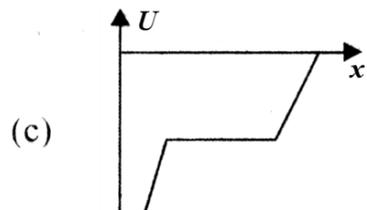
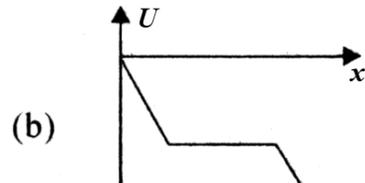
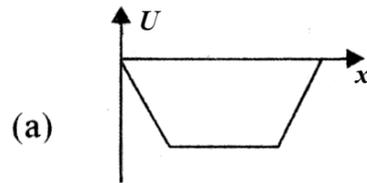
6. The period of revolution of a satellite around the Earth is T . What is the period of the satellite if the radius of the orbit is multiplied by 4?

- T
- $2T$
- $\sqrt{2}T$
- $8T$

7. Here is the graph of force on an object as a function of the position. Which of the following graphs correctly represents the graph of the potential energy as a function of the position?



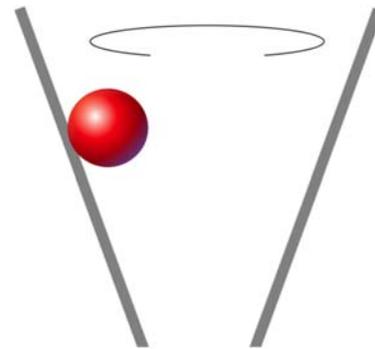
- a
- b
- c
- d



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8. Maxime is in a space station in orbit around the Earth while Laurence is in a station in orbit around Jupiter (which has a greater mass than the Earth). If the radiuses of the orbits are the same, who experiences the greatest number of g?
- Maxime
 - Laurence
 - The number of g is the same for both, but it is not zero.
 - The number of g is zero for both.

9. A ball making a circular motion in a cone always stays at the same height as shown in the figure. As there's no friction, the speed is constant.



The weight of the ball is _____ (<, > or =) the normal force acting on the ball.

If the ball were making a circular motion higher in the cone (therefore with a larger radius), then the centripetal force would be _____ (larger, smaller or the same).

If the ball were making a circular motion higher in the cone (therefore with a larger radius) then the speed of the ball would be _____ (larger, smaller or the same).

10. A box is placed on the rear platform of a truck. The truck is moving to the right. If the truck slows down and the box does not slide on the platform, then the frictional force exerted on the box is...



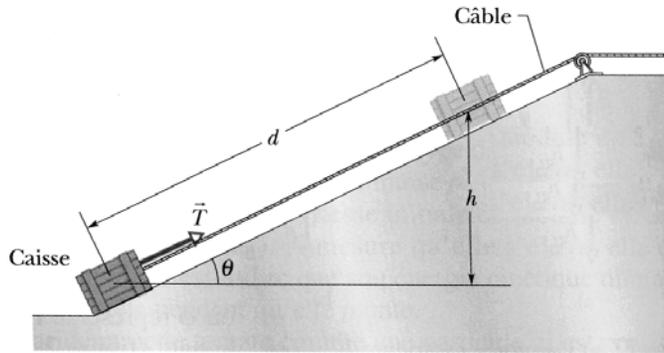
- directed towards the right and its magnitude is exactly $\mu_s F_N$.
- directed towards the right and its magnitude is not necessarily $\mu_s F_N$.
- directed towards the left and its magnitude is exactly $\mu_s F_N$.
- directed towards the left and its magnitude is not necessarily $\mu_s F_N$.

Answers: 1a 2: 5 N 3d 4: 25J 5: only d is true 6d 7b 8c 9 <, the same, larger 10d

11. (20 marks)

Audrey is pulling a box of shrimp ($m = 15 \text{ kg}$) up an incline with a rope. The 30° incline has a length of $d = 30 \text{ metres}$. The coefficient of static friction between the incline and the box is 0.35 and the coefficient of kinetic friction between the incline and the box is 0.25. If the box was initially at rest, calculate...

- the minimum tension force needed to put the box in motion.
- the acceleration of the box if the tension is $T = 200 \text{ N}$.
- the speed of the box at the top of the incline, using the acceleration found in b).

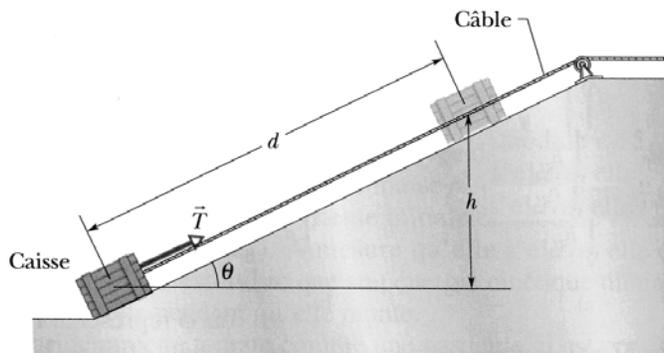


Answers: a) 118.06 N b) 6.31 m/s^2 c) 19.46 m/s

12. (20 marks)

Mathis is pulling a box of calculators ($m = 15 \text{ kg}$) up an incline with a rope. The 30° incline has a length of $d = 30 \text{ metres}$. The tension of the rope is $T = 200 \text{ N}$, and the coefficient of kinetic friction between the incline and the box is 0.25. If the box was initially at rest, calculate...

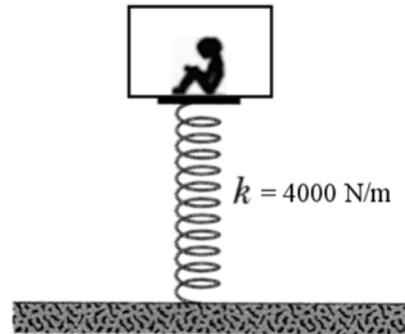
- the work done by gravity.
- the work done by the normal force.
- the work done by the frictional force.
- the work done by Mathis (the rope).
- the speed of the box at the top of the incline, using the net work.
- Mathis's average power (in hp).



Answers: a) -2205 J b) 0 J c) -954.8 J d) 6000 J e) 19.46 m/s f) 2.61 hp

13. (15 marks)

Charles is inside a box placed on a spring. (The box is simply placed on the spring, it is not attached to the spring.) Initially, the spring is compressed 3 m. The mass of the box (including Charles) is 100 kg.



- a) What will be the maximum height reached by the box if it is released? (The height is calculated from the position of the box when the spring is compressed and friction is neglected.)
- b) What is the number of g experienced by Charles just at the moment when the box is released?

Answers : a) 18.37 m b) 12.24

14. (15 marks)

A 1500 kg satellite is in a circular orbit at an altitude of 2000 km above the Earth's surface.

- a) What is the speed of the satellite?
- b) What is the period of the satellite?
- c) What is the net force acting on the satellite?
- d) How much energy must be given to the satellite to increase the altitude to 3000 km?

Earth radius= 6400 km
Earth mass = 6×10^{24} kg

Answers: a) 6904 m/s b) 7644 s c) 8513 N d) 3.8×10^9 J